Enraf Annulus Leak Detector

The Challenge

The Hanford Site contains 177 cylindrical underground storage tanks that contain 55 million gallons of hazardous and radioactive wastes. The tanks are reinforced concrete structures with inner carbon steel liners. Tanks are split into two groups based on their design: 149 tanks have a single carbon steel liner and 28 tanks have two steel liners separated by a space called the annulus. The annulus provides a margin of safety in the case of leaks because the leak can be detected and the waste removed before it might escape. The annulus is roughly a 30-inch wide space surrounding the 75-foot diameter primary inner tank. The bottom of the tank is approximately 56 feet below ground. The Washington State Department of Ecology (WDOE) requires that an accumulation of 0.5 inch or less of liquid in the bottom of the annulus be detectable. Temperature changes within the annulus, coupled with the extreme depth and inaccessibility of the tank make for difficulties in identifying reliable technologies that are not affected by atmospheric and environmental changes. The challenge is finding a device that is reliable, accurate and simple to implement.

An Enraf level gauge leak detector with custom designed displacer suspended by a thin metallic alloy wire.

Current Approach

The technology currently used to detect leaks into Hanford's double-shell tank annuli is conductivity based. A plummet – or steel plumb bob – is suspended from a manually adjustable flat steel tape at approximately 0.5 inch above the annulus bottom. Should liquid be introduced into the annulus, an electrical circuit is completed after it touches the plummet. Relays then activate various audible and visual alarms, notifying operators that a leak has occurred.

Widely varying temperatures within the annulus often cause thermal expansion to occur within the steel tape attached to the plummet. The expansion/contraction can either cause false readings, or set points greater than 0.5 inch.

Many of the newer model devices are fabricated from thick polycarbonate plastic sheets assembled with adhesive cement. Exposure to ultraviolet radiation from the sun turns the adhesive to powder, thereby causing the devices to fall apart. Replacement of these devices is cost prohibitive requiring custom fabrication and assembly, since they are not commercially available.

Benefits and Features

- More accurate leak detection
- Reliable operation
- Technicians already familiar with the instrument
- No guess work with set points
- Remote alarming capability

New Technology

The Enraf™ Series 854 ATG (Advanced Technology Gauge) is a level detector that has the capability to track level changes in liquids and solids. These level detectors are being deployed on double-shell tank annuli. The Series 854 ATG is widely used throughout the tank farms for primary tank waste surface level measurement. Deploying the Enraf™ as an annulus leak detector is a logical extension of its capabilities.

The gauge operates on the principle of buoyancy to track level changes within the tank. A plummet – referred to as a "displacer" – is lowered into the tank until it encounters an upward force, such as from a liquid or solid, at which point it stops. The instrument tracks the position of the displacer and reports the level of the encountered liquid or solid.

In the annulus leak detection mode, the displacer rests on the bottom of the annulus, waiting for liquid to rise beneath it. A certain amount of liquid must enter the annulus before the gauge can detect the upward force. The amount of liquid necessary to lift the displacer from the floor of the tank annulus is approximately 0.19 inch. The instrument has an accuracy of ± 0.04 inch and a repeatability of 0.004 inch.

Deployment of the Enraf Annulus leak detector, compared to the baseline method, minimizes operator judgement, and results in more accurate data and reliable performance. Deployment was initially in tank 101-SY and planned for other DSTs. Additionally, technicians and engineers are familiar with its functional capabilities, operation and maintenance. Therefore, little or no additional training will be required. The technology achieves the regulatory requirement for leak detection in the tank annulus and provides an alarm in the event of a detectable leak.

Information Contacts
J. H. Huber, Lockheed Martin Hanford Corporation
(509) 373-5549
G. T. Frater, FDH Technology Management
(509) 372-4291
D. A. Brown, DOE-RL Science and Technology Programs, (509) 372-4030

Technology Vendor
Enraf Nonius Inc.
500 Century Plaza Drive
Suite 120
Houston, Texas 77073
(713) 443-4291

Funding for technology deployment was provided by the U.S. Department of Energy.

Fluor Daniel Hanford, Inc., Technology Management
TM-DEP-99-016